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Stereophotography of malacological objects

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A b s t r a c t : The present contribution deals with the significance and application of stereoscopic photography in malacology. Basically, shells of gastropods and bivalves with sizes greater than 1 cm can be photographed by using a stereo-camera or an ordinary single-objective camera, thereby recording the item from two different positions. Shells with sizes smaller than 1 cm, on the other hand, are photographically documented with the help of a stereo-microscope, where shot of the object takes place separately through both oculars. Stereoscopic description of living animals is only possible with a double-objective camera allowing the synchronous production of both stereo-images. Various examples of stereo-pairs are presented and their importance for malacological science is discussed.

K e y w o r d s : Stereoscopy, malacology, stereo-camera, stereo-microscope, gastropods, bivalves.

Introduction

During the past decades stereophotography has successively found its entrance into the world of natural sciences. Today numerous scientific disciplines such as zoology, botany or cell biology use this method in order to obtain better information of specific objects and structures (STURM 2016a, 2016b, 2017a). As already outlined in previous contributions, stereophotography has become an important technique of visualization in entomology in the meantime (STURM 2017a, 2017b, 2017c, 2017d). This development, however, is founded upon several reasons: First, the production of stereo-images is not associated with high technical expenditure, because most shots can be also made with the help of a single-objective camera (STURM 2016a). Second, stereoscopic techniques are equally applicable to normal photography, light-microscopy, and electron-microscopy, representing the main visualization methods in insect science. In all these fields stereo-pairs are commonly produced according to the same principles. Third, modern stereoscopic software enables the generation of stereo-images from a single photograph of an item (RAAP & CYPIONKA 2011, CYPIONKA et al. 2016, STURM 2017b), so that old shots of insects or microscopic images can be filled with 'new life'.

As exhibited in previous publications (STURM 2013, 2015), all kinds of imaging play an important role in malacological science. Whilst detailed photographs of shells are among other required for the exact systematic classification of an organism, images of living animals represent a valuable support for ecological and behavioral research. STURM (2011, 2015) could demonstrate that stereoscopic photography can be applied for a better visualization of three-dimensional shell structures, being an essential distinctive mark between different species. In addition, stereo-images show the object in a more realistic fashion and thus give a better idea of its phenotype.

The present contribution pursues two main goals: Besides a brief description of stereoscopic imaging techniques being applicable to malacological objects, also several examples of stereo-pairs are presented. Finally, the significance of stereophotography in malacology is subjected to an intense debate.

Material and Methods

Since basic principles of stereoscopic photography have already been presented in detail in numerous previous contributions (STURM 2016a, 2016b, 2017a, 2017b, 2017c), only the most salient features of this optical technique being worthy of note in association with malacological problems will be described here. For the production of appropriate stereo-images two main categorizations have to be carried out: First, a distinction between empty shells on the one hand and living objects on the other hand has to be made. Second, empty shells have to be attributed to two size classes, i.e., shells exceeding a size of 1 cm and shells having a size smaller than 1 cm. Large shells can be handled with the help of ordinary macro-photography, whereas imaging of small shells usually requires the application of a stereo-microscope.

Photography of large shells can be either conducted with a stereo-camera or carried out with a single-objective camera, whereby in the latter case the objects have to be shot from two different positions being horizontally displaced by 6.5 cm (STURM 2016a). Small shells viewed under the stereo-microscope can be documented stereoscopically by simply photographing the objects through both oculars (STURM 2016a, 2016b). In the case of living animals things become a little more complicated insofar as imaging of larger objects unconditionally requires a stereo-camera. For small organisms stereo-images are best reconstructed from single photographs made at the stereo-microscope, because other procedures such as the use of two synchronized cameras (identical types) usually prove to be too sumptuous.

Viewing of stereo-pairs like those presented below can be done by using specific aids (stereo-glasses, stereoscope) or by application of so-called autostereoscopic techniques (parallel view, crossed-eye view). Learning of these methods is described in detail by STURM (2016a).

Results

Stereophotography of large shells (> 1 cm): Some examples of stereo-pairs of rather large shells are summarized in Fig. 1. The uppermost stereo-image shows the shell of the indigenous aquatic snail *Viviparus contectus*, measuring about 4 cm in height. The object is characterized by its striped whorls and perfectly rounded mouth. With the help of the three-dimensional view of this object a better impression of the curvature and spatial extension of the shell can be obtained. The same thing becomes true for the tropical gastropod *Cyprea* sp. depicted in the middle image. The shell of this organism is marked by its bulgy and oviform shape on the one side as well as its slit-like mouth on the other side. The shell has a length of about 5 cm. The most impressive stereo-image can be obtained from the tropical gastropod species *Murex* sp., representing the lowermost example of Fig. 1. The about 10 cm high shell of this organism is distinguished by its long

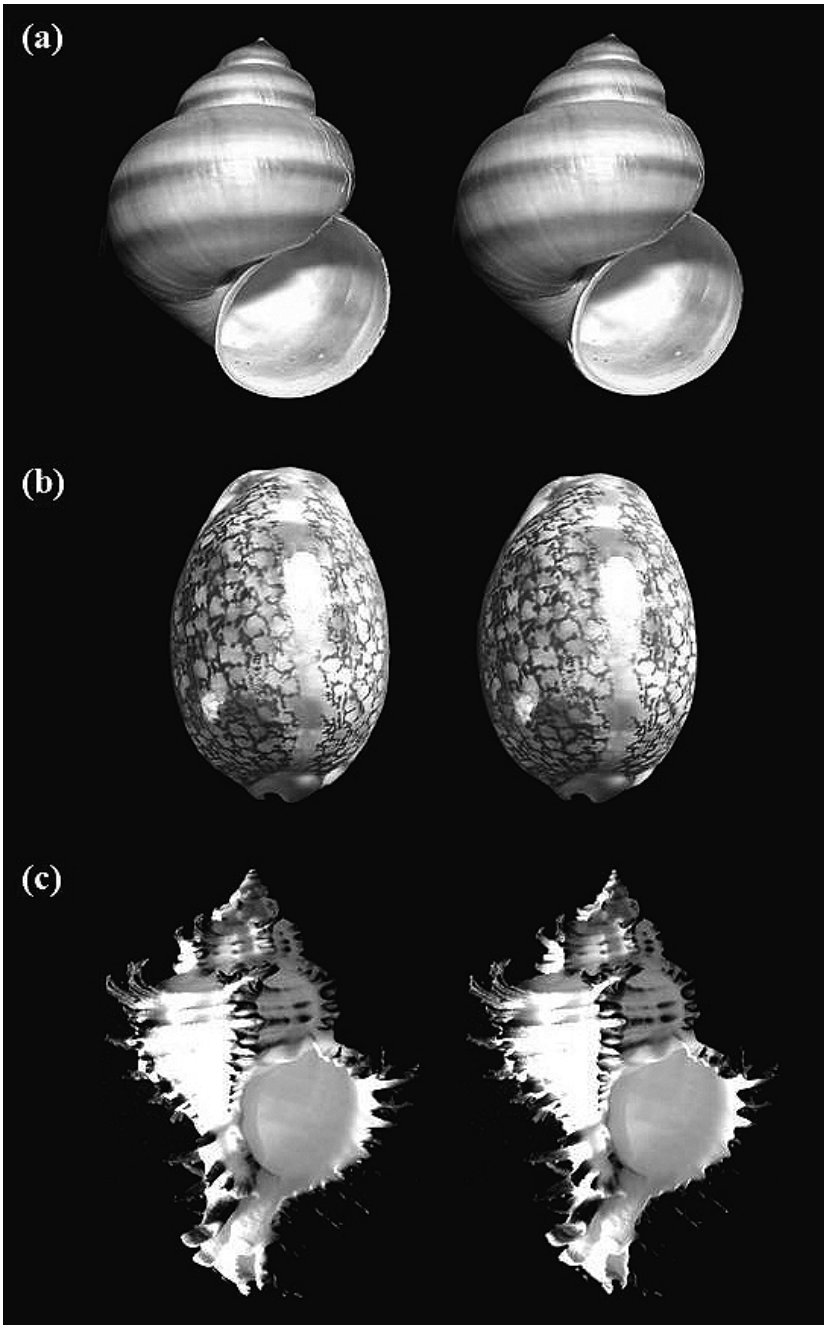


Fig. 1: Stereo-images of gastropod shells which are larger than 1 cm: (a) *Viviparus contectus*, (b) *Cyprea* sp., (c) *Murex* sp.

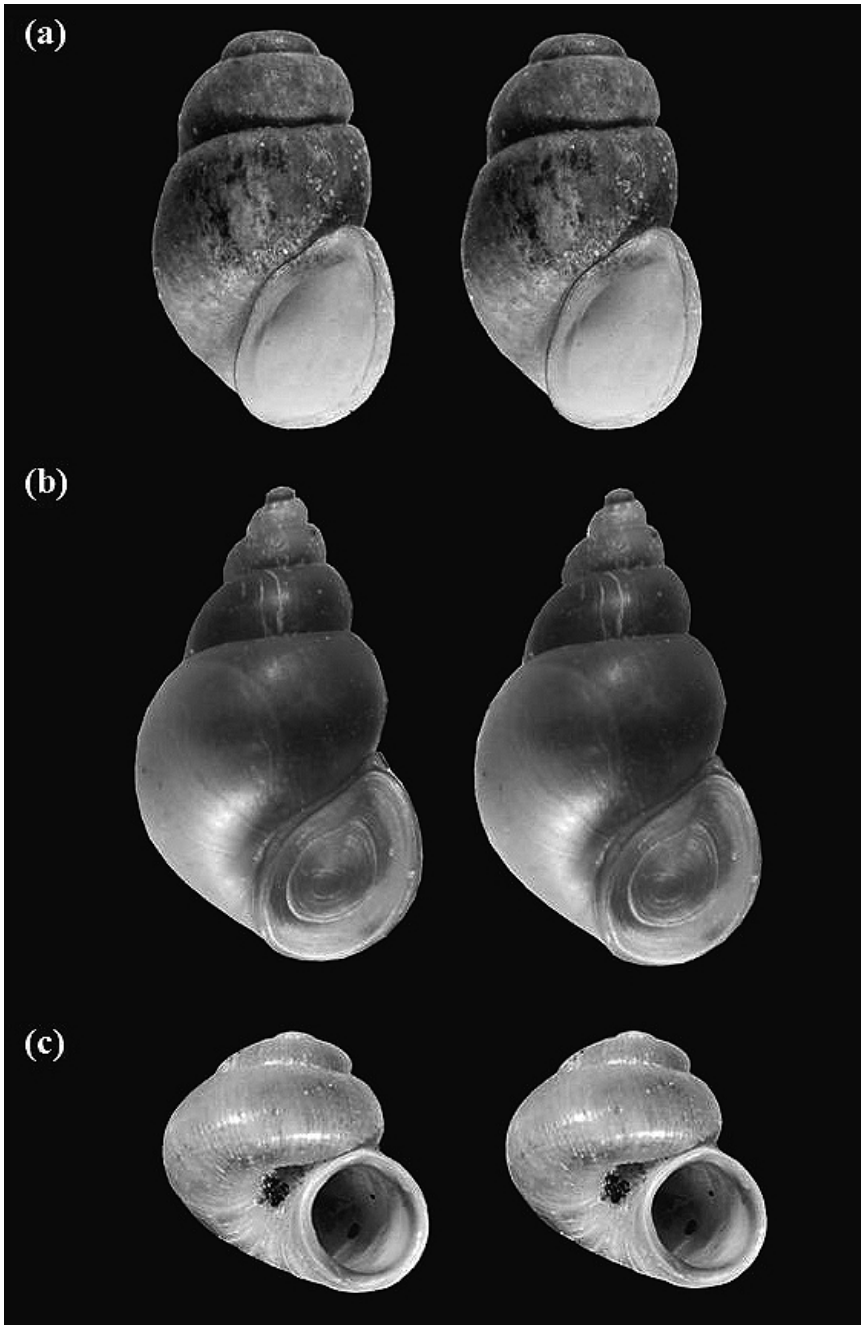


Fig. 2: Stereo-images of gastropod shell with lengths below 1 cm: (a) *Bythinella austriaca*, (b) *Bithynia tentaculata*, (c) *Valvata piscinalis*.

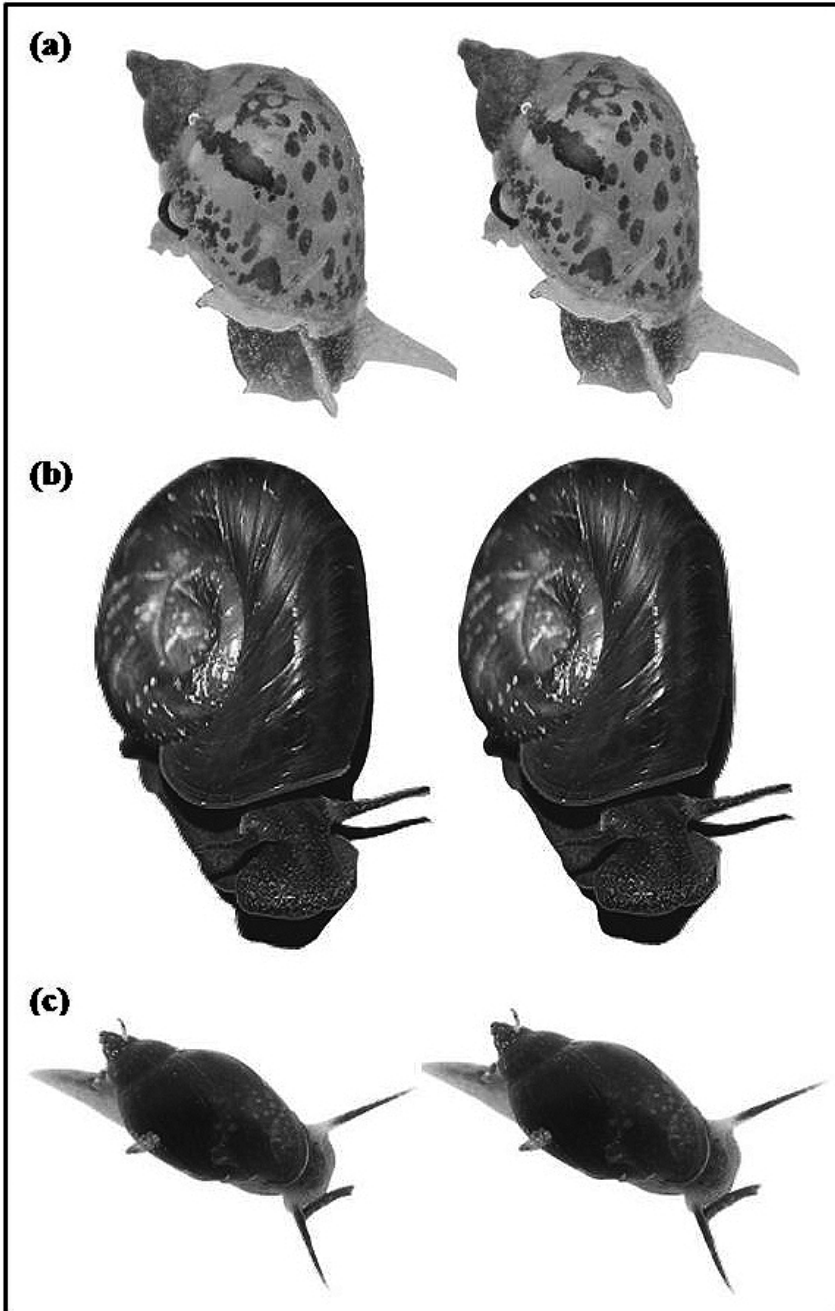


Fig. 3: Stereo-photographs of living gastropods: (a) *Radix balthica*, (b) *Planorbarius corneus*, (c) *Bithynia tentaculata*.

specific extinctions, whose spatial arrangement can be better duplicated in the 3D-image.

Stereophotography of small shells (< 1 cm): Numerous aquatic gastropods and bivalves of indigenous running and stagnant waters commonly measure below 1 cm in size. Therefore, they have to be investigated by using magnifying glasses or a stereo-microscope. One of these species, which was subjected to comprehensive ecological studies in the past (STURM 2005, 2016c), is the Austrian spring snail *Bythinella austriaca* (Fig. 2a). The shell of this gastropod has a height of about 3.5 mm and a very characteristic barrel shape with peaky mouth. These properties, however, are significantly accentuated in the stereoscopic image. Such a pronunciation of the three-dimensional extension can be also recognized for the shell of *Bithynia tentaculata* (height: 8 mm) with its typical winter operculum for outlasting the cold season (Fig. 2b). The shell of the gastropod species *Valvata piscinalis* commonly reaches a height of 5 mm and is marked by its rather bulgy appearance, which can be depicted in a better way by stereoscopic photography (Fig. 2c).

Stereophotography of living animals: As already mentioned in the preceding section, stereoscopic imaging of living animals is best realized by using a double-objective camera that allows the synchronous production of the stereo-images. Some examples of such stereo-pairs are summarized in Fig. 3. The gastropod species *Radix balthica* (Fig. 3a) measures 1-1.5 cm in length and is mainly distinguished by its broad foot and its triangular tentacles. The species *Planorbarius corneus* (Fig. 3b) reaches a size of up to 2 cm, whereby the animal carrying the planar shell has a rather dark appearance with long and thin tentacles. This last characteristic can be also observed for *Bithynia tentaculata* (Fig. 3c), where the individual is marked by a narrow foot but a broad head.

Discussion and Conclusions

In the 20th century nature science was successively enriched by innovative imaging methods, among which several types of electron-microscopy or laser-scanning microscopy can be particularly pointed out. The demand for the production of spatial or three-dimensional images already came into being at the beginning of the century, when meteorologists and geographers recognized the enormous advantage of stereoscopic techniques for the first time (SCHEIDEL 2009, STURM 2016a, 2016b). It needed some more decades, until stereoscopy also found its entrance into the biological disciplines, whereby the use of this optical technique became most popular with the establishment of electron-microscopy in the laboratories (STURM 2016a). For the detailed investigation of microstructures on the one hand and microorganisms on the other hand stereoscopic imaging continuously advanced to a standard method (GOLDSTEIN et al. 2003, STURM 2017a, 2017b). A very similar development could be observed in insect science, where three-dimensional photographs do not only have a major scientific value, but are also increasingly used for pedagogical purposes (STURM 2017c, 2017d).

Malacology bears a similar potential for the application of stereo-imaging as entomology. As could be demonstrated in the results section, realistic visualization of shell shapes and organismic phenotypes can only be guaranteed by the use of a three-dimensional photographing procedure. Previous studies were able to demonstrate that stereoscopic techniques bear several advantages with regard to species determination and visual accentuation of specific structural characteristics (STURM 2009, 2011, 2015). It

was concluded that stereoscopy might become an essential optical technique in association with the investigation of gastropods, bivalves or other molluscs. This rather optimistic assessment can be also confirmed by the data presented in this contribution.

Zusammenfassung

Stereofotografie von malakologischen Objekten. – Der vorliegende Beitrag beschäftigt sich mit der Bedeutung und Anwendung der stereoskopischen Fotografie in der Malakologie. Grundsätzlich können Gehäuse von Gastropoden und Muscheln mit einer Größe von über 1 cm durch Verwendung einer Stereokamera oder einer gewöhnlichen Einzelobjektivkamera aufgenommen werden, wobei der Gegenstand in letzterem Fall aus zwei unterschiedlichen Positionen abzulichten ist. Gehäuse mit einer Größe unter 1 cm werden andererseits mithilfe eines Stereomikroskops fotografisch dokumentiert, bei dem die Objektaufnahmen getrennt durch die beiden Okulare erfolgen. Die stereoskopische Beschreibung lebender Tiere ist nur mit einer Doppelobjektivkamera möglich, welche die synchrone Produktion der beiden Halbbilder gestattet. Verschiedene Beispiele von Stereobildpaaren werden präsentiert, und ihr Nutzen für die malakologische Wissenschaft wird diskutiert.

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